

Maine Streams: Overview of the Biology



Today's Lesson!

What are primary organizing factors that determine biological characteristics of Maine streams.

What type of plants and animals live in and around Maine streams.

Stream food webs and energy flow.

Types of response to (human) change.

How is this information used in water quality programs.



Organizing factors for Maine Streams and Rivers

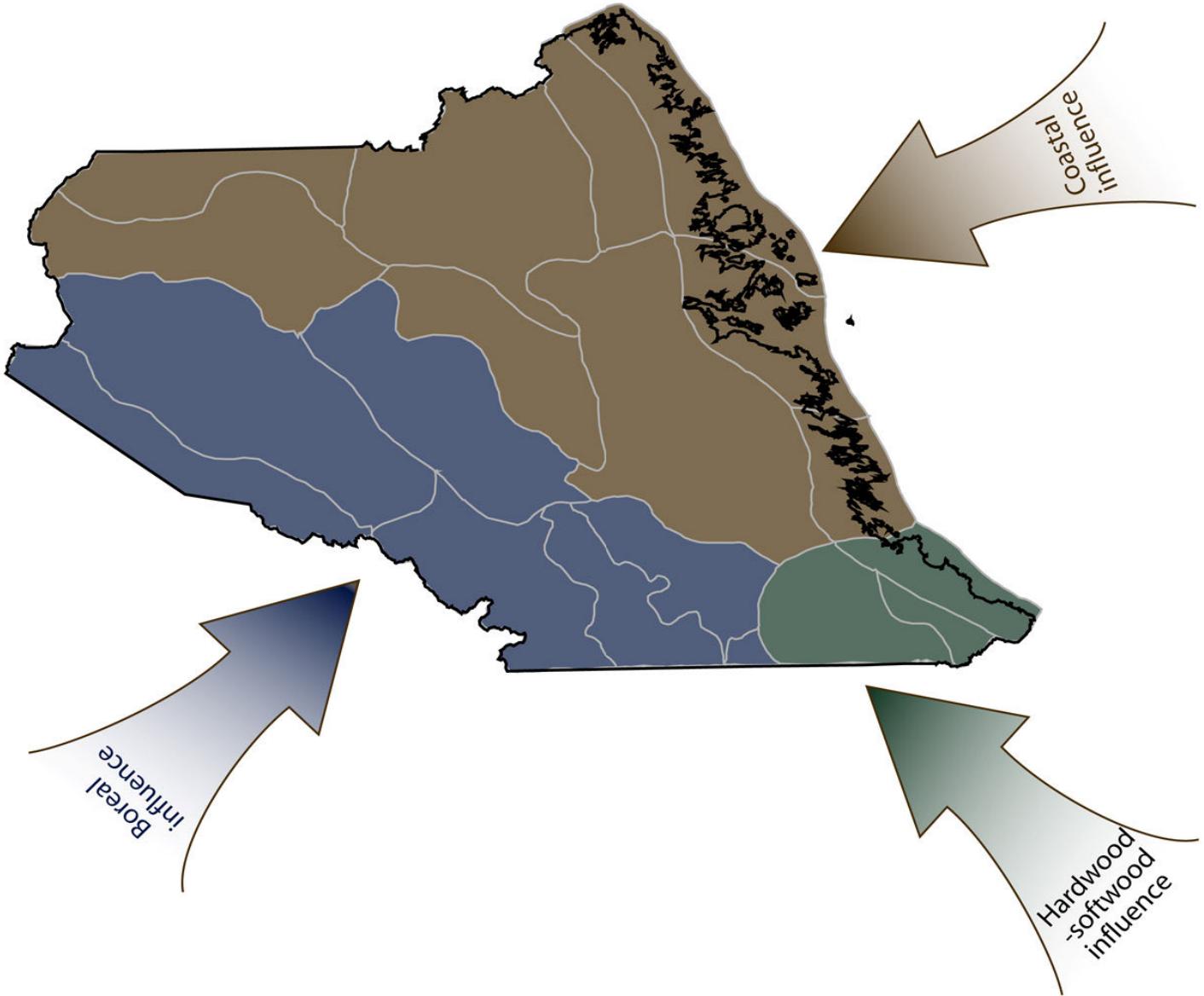


- Continental glaciers
- Ecoregional patterns
- Waterbody setting
- Hydrologic regimes
- Seasonality

Continental glaciers

- Maine waters are young – presumably we may be still (naturally) acquiring species.
- Waterbody connects and disconnects are relatively recent.
- Short period of time for local speciation to occur
- Low endemism – e.g. relatively few mussel species, few minnow species, relatively rich insect fauna

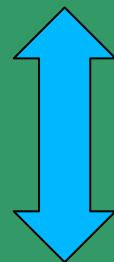
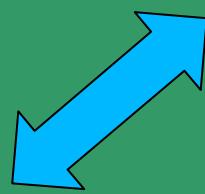


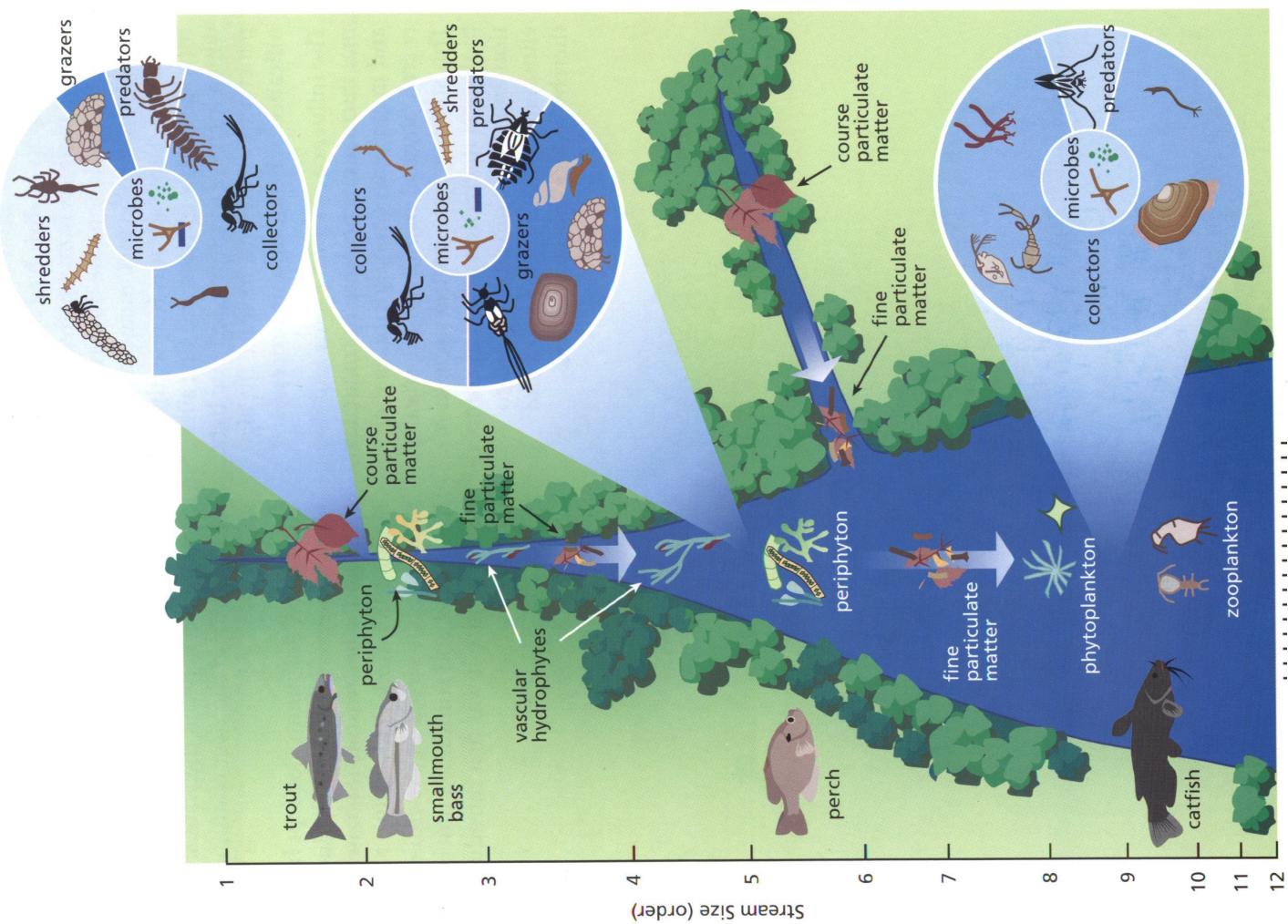


Ecoregional patterns

Maine is at the convergence of three major biogeographic regions:

- temperate hardwood forest
 - boreal forest
 - ocean
- which results in unique species interactions.





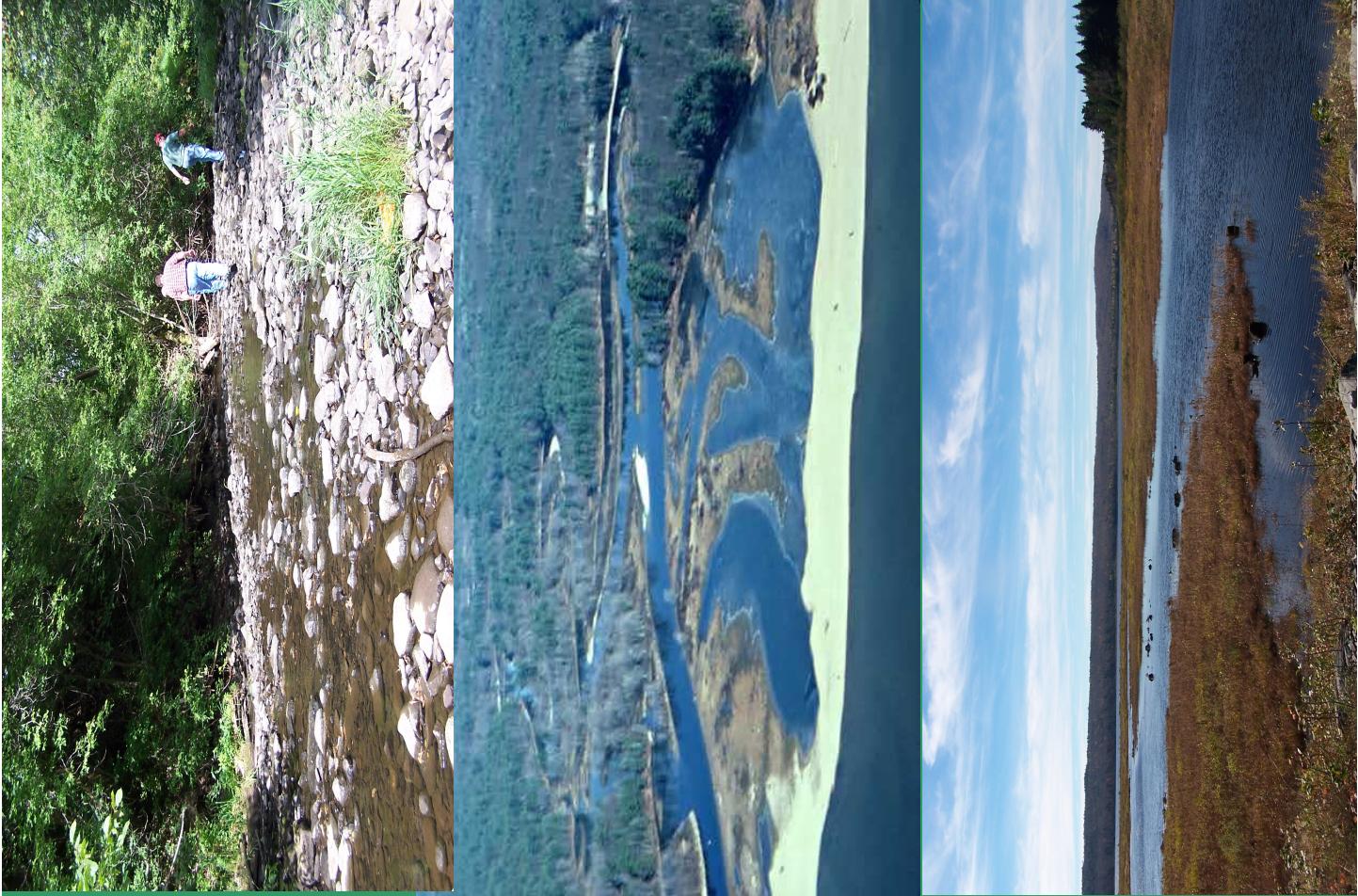
Waterbody setting

“River Continuum Concept”

organic matter, nutrients, are processed in a predictable downstream manner which may determine general functional makeup of the aquatic community

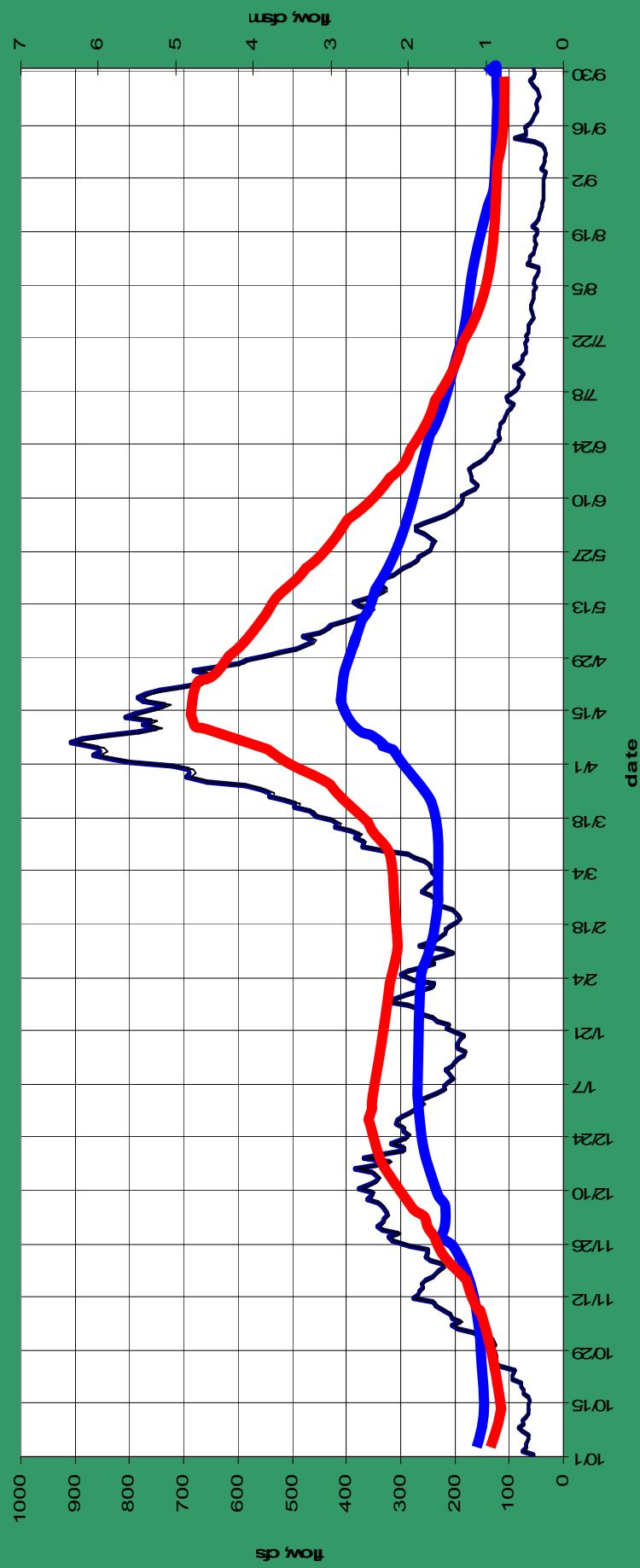
Hydrologic regimes

- Stream hydraulics
 - vertical fluctuation
 - surface/groundwater ratio gradient
- Flood pulse
 - horizontal fluctuation
- Serial discontinuity
 - flow dampening from lakes and wetlands



Unregulated flow – 30 year record Sheepscot River (black)

River Hydrograph
(Sheepscot River)



Seasonality

- Affects metabolic rates
- Determines amount and type of primary food sources
- Organism movement / migration
- Life cycles
 - Reproduction, hatching
 - Insect emergence

Summer

- Low flow
- High temperature
- High shade
- High photosynthesis
- High metabolism



Autumn

- High organic input (CPOM)
- Moderate flow
- Declining temperature / metabolism
- Insect recruitment





Winter

- Low flow
- Low organic input
- Low metabolism



Spring

- Highest flow
 - High organic input
 - Migration / emergence
 - Fish recruitment
- 



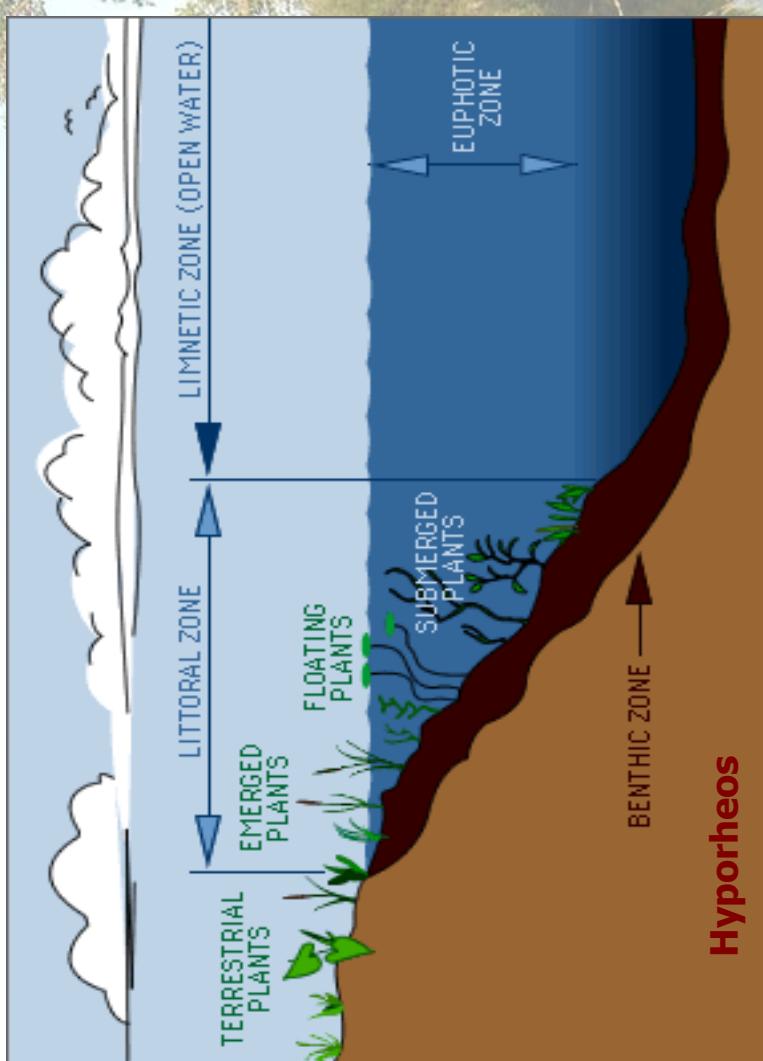
Biological Characteristics

**Streams and rivers have 5 basic zones
each with distinctive flora and fauna:**

**Floodplain Riparian
Water column Hyporheic
Benthic**



The “Anatomy” of Maine’s Streams



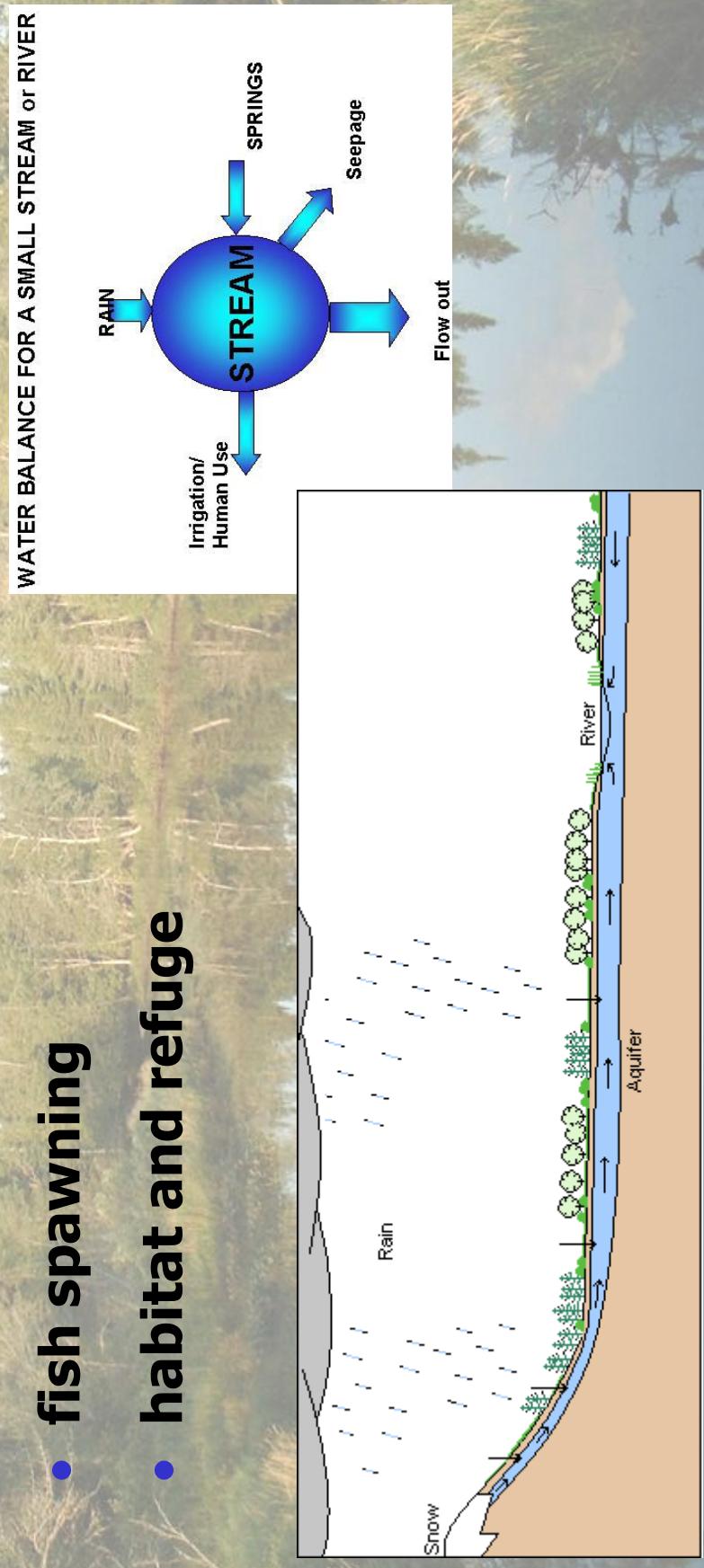
Floodplain
Riparian
Water column
Benthic
Hyporheic

Maine’s rich diversity of habitats, substrate types, flow conditions, wetlands, and floodplain forests are vitally important for aquatic biological diversity.

Hyporheic Zone

"the region beneath and lateral to a stream bed"

- mixing of shallow groundwater & surface water.
- may provide unique chemical properties
- fish spawning
- habitat and refuge



Benthic Zone

"the river or stream bed"

Substrate of mud, sand, gravel, boulder, and organic debris

Shallow benthic environments are those towards the shore

Deep benthic environments are those from the shore margin to deep waters

Diatoms, algae: yellow or brown coloring of rocks (slimy feel)

Aufwuchs: fuzzy coating of algae, protozoa, diatoms, bacteria & fungi

rich in nutrients and macroinvertebrates



**Habitat, foraging, hiding & spawning:
Insects, mollusks, crayfish,
Sculpin, suckers**

Water column

A water column is a conceptual column of water from surface to bottom sediments.

Zone of water mixing

**Provides the interface/ exchange with both
hyporheic water and atmosphere**

Free floating and free swimming organisms

Plankton

Submersed plants

Filtering organisms

Fish



Riparian Zone

**"pertaining to, situated, or dwelling
on the bank of a river or other water body"
"the interface between land and a flowing surface water body"**

Dissipate stream energy: meandering curves of a river, combined with vegetation and root systems buffer energies from weather events, urbanization

Trap sediment: replenishment of & building of stream banks

Enhanced nutrient cycles: contributions of terrestrial vegetation (e.g. leaf litter and insect drop) to aquatic food webs

Provide wildlife habitat and corridors: increase biodiversity, movement and forage for wildlife.

Provide native landscape irrigation: extending seasonal & normal flows of water, relative humidity.

Shading water: mitigate water temperature changes, suppress instream photosynthesis

Riparian Zone

Dominant food source for aquatic invertebrates

Influence the growth and survival of aquatic fauna

Essential to maintain water quality conditions:
cool water temperatures preferred by Atlantic
salmon and brook trout

Easily damaged or altered
construction
forestry
agriculture



Riparian Zone

Emergent Herbaceous Plants
Grasses, Rushes
Ferns
Woody Shrubs
Canopy Trees



Floodplain & flood fringe

**Seasonally and
'event' available
habitat.**

**Import/export
of organic matter**



The historical use of floodplain for development?

fertile land and water for farming;
inexpensive transportation;
easier to develop than hilly land



Floodplains

"the flat or nearly flat land adjacent to a stream or river experience and are formed by the deposition of sediments during periodic floods"

includes floodway, flood fringe, backswamps, delta plains, and oxbow lakes.



Floodplain dependent species:

Siphlonisca aerodromia (Tomah mayfly)

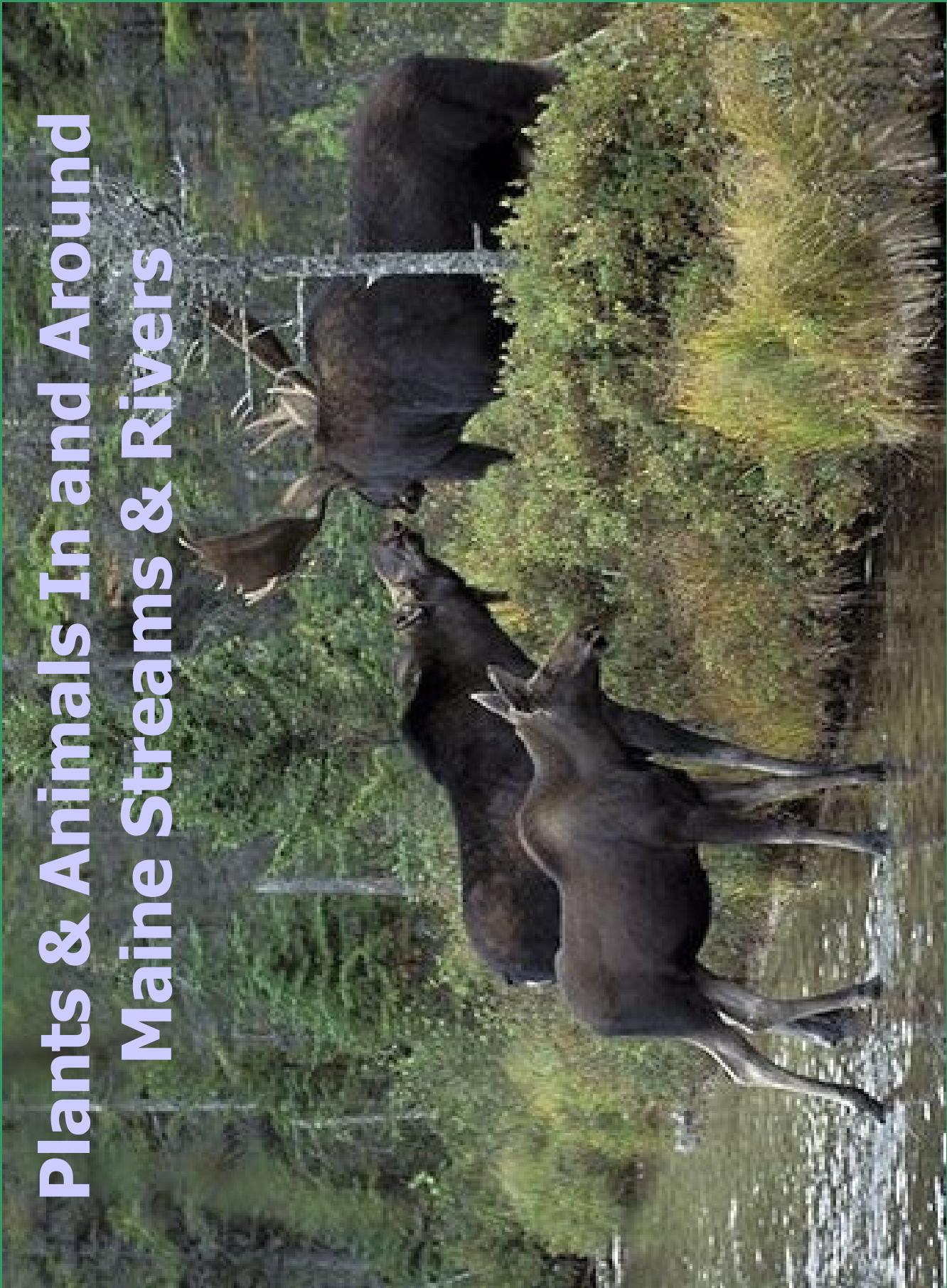


A “stream species” for
11 months of year



Dependent on availability
of spring flooding of sedge
meadows to accomplish
>50% of final growth before
emergence in June.

Plants & Animals In and Around Maine Streams & Rivers



Microbes & Microrganisms

*Microbe = any organism that is microscopic;
Too small to be seen with the human eye!*



Generally single-celled: bacteria, fungi, etc

Microorganisms that live almost anywhere there is water:

- Critical to "conditioning" organic matter
- Critical to nutrient recycling
- Natures "decomposers" & nitrogen "fixers"



Algae

"groups of living aquatic organisms that capture light energy and use photosynthesis to convert inorganic substances into organic matter".



Algae are photosynthetic organisms

- occur in most aquatic habitats
- "simple plants" – one-celled but can occur as large connected filaments or colonies
- produce about 73 -87 % of the net global production of oxygen for life respiration.



Plants in Maine Waters

Approx 125 native aquatic species
5 invasives

Maine Volunteer Lake Monitoring Program

Maine Center for Invasive Aquatic Plants

Virtual Herbarium

[About](#) [Background](#) [Support](#) [Partners](#) [Credits](#)

Herbarium

[Home](#) [Scientific Name](#) [Common Name](#) [Native Plants](#)

Invasive Plants

[Look Alike](#) [Invasives](#) [Glossary of Terms](#) [Image Gallery](#)



<http://www.mciap.org/herbarium>

The virtual herbarium is Maine's online resource for aquatic plants. Browse through the collection using the menu items at the left side of your screen.



Macrophytes

*"a plant, especially an aquatic plant,
large enough to be visible to the human eye, usually with
vascular structures"*



Emergent (edge-riparian)

rooted in substrate with the tops
of the plant extending into the air

Submersed (benthic, water column)

grow completely submersed
under the water

Floating-leaved (edge-pools)

rooted to the lake bottom with
leaves that float on the surface of
the water

Freely floating (ponds, pools)

float on or just under the
watersurface with their roots in the
water and not in sediment



Invertebrates & Macroinvertebrates

"an animal without a spinal column, including insects, which inhabit a stream channel, pond, lake, or wetland "

Invertebrates comprise 97% of all animal species abundance & diversity are indicators of ecosystem health



- Key component of the food chain: most stream species are benthic

- Abundance and diversity determined by:
Flow, food, habitat & water quality
- Pollution sensitive
mayflies, caddisflies,
- Pollution tolerant
aquatic worms, leeches, snails



Diversity of Macroinvertebrates (majority are stream/river dwellers)



- Mayflies – 170 species
- Stoneflies – 120 species
- Caddisflies – 342+ species
- Blackflies – 46 species
- Dragonflies/damselflies – 158 species
- Crayfish – 8 species
- Mussels – 10 species

Amphibians

"four-legged vertebrates that do not have amniotic eggs, and whose body heat is regulated by the external environment"

- 9 salamander, 9 frog species
- Most species spend part of their time on land.
- All require water for breeding, early life stage
- Vernal pool indicator species



Reptiles

"four-legged vertebrates, animals whose embryos are surrounded by an amniotic membrane"



- Turtles associated with streams, floodplains, riparian zones
- Northern water snake and ribbon snake "semi aquatic" generally associated with riparian zone and water.



Fish

"limbless aquatic vertebrate with fins and internal gills"

- 71 Maine species (49 native)
- Geographically more diverse in southern Maine
(larger number of non-native species, coastal species)
- Maine species are predators or omnivores
 - diets vary with species, life stage, season and consist of: zooplankton, macroinvertebrates, other fish
- Some fish are scavengers in the benthic zone and may ingest algae and detritus.

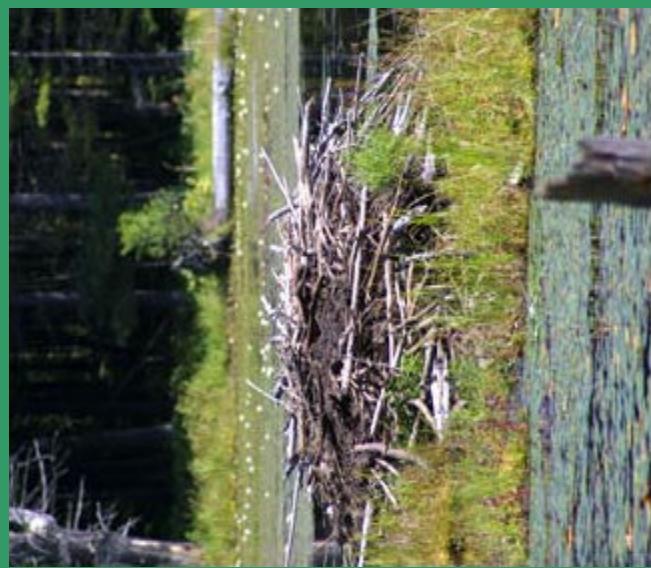


Birds Associated with Maine Waters

'habitats' -
including the
wetlands and
streamsides
vegetation, are
important for
70% of bird
species.



Mammals Native to Maine Waters



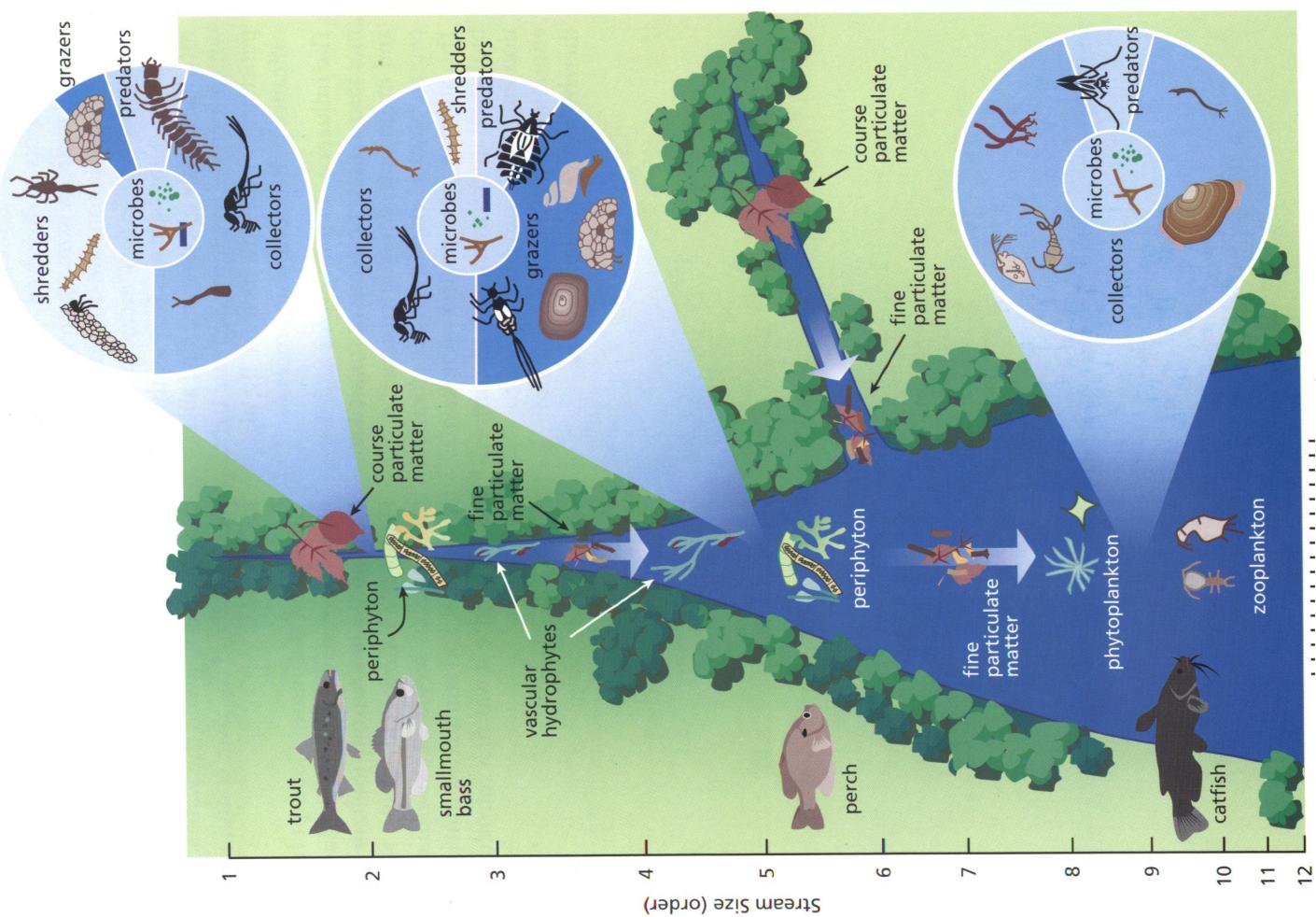
Energy Cycles & Food Webs



Sources of food

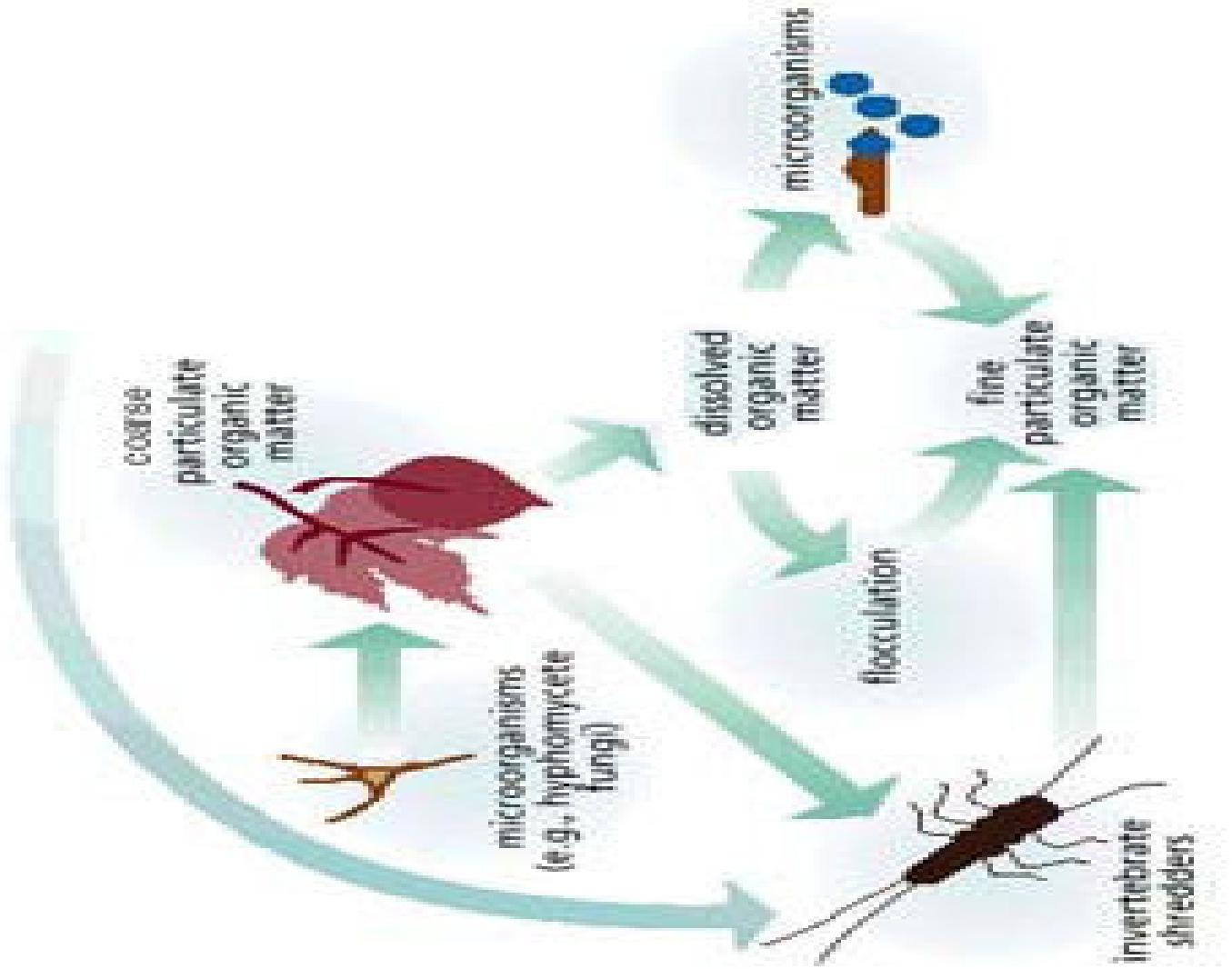
- *Allochthonous*
Food & Energy entering the stream from outside sources
Organic matter washed into the stream
- *Autochthonous*
Food & Energy originating in the stream
- Algae
- Macrophytes
- Leaves and other terrestrial organic debris falling from riparian / floodplain zone.
- Organic substances leaching through groundwater.
- Oceanic fish migration





Organic matter processing

- Shredders – reduce large materials (e.g. leaf litter)
- Grazers – graze on green plant material (e.g. algae)
- Collectors-gatherers
 - Filter-feeders
 - Deposit-feeders
- Predators



Coarse organic material

(leaves)

“Conditioning”

Shredding - CPOM

Filter/ Collect - FPOM

Dissolved matter

Primary production

Grazing

Shredders



Collectors

Deposit-feeders



Grazers

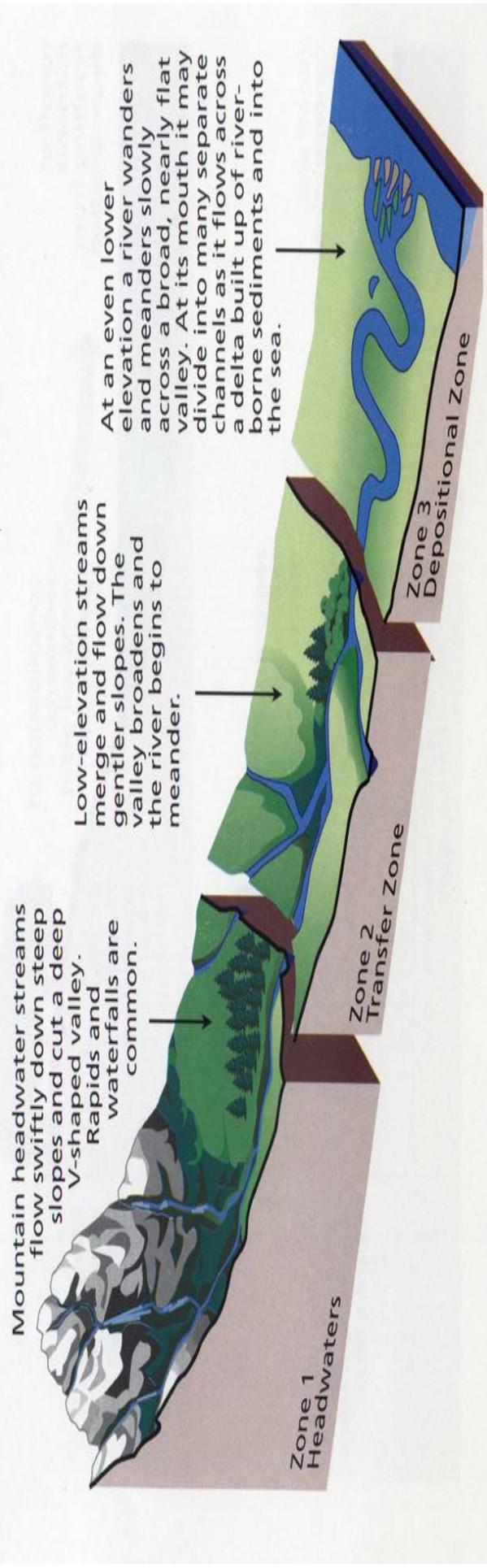


Filter-feeders

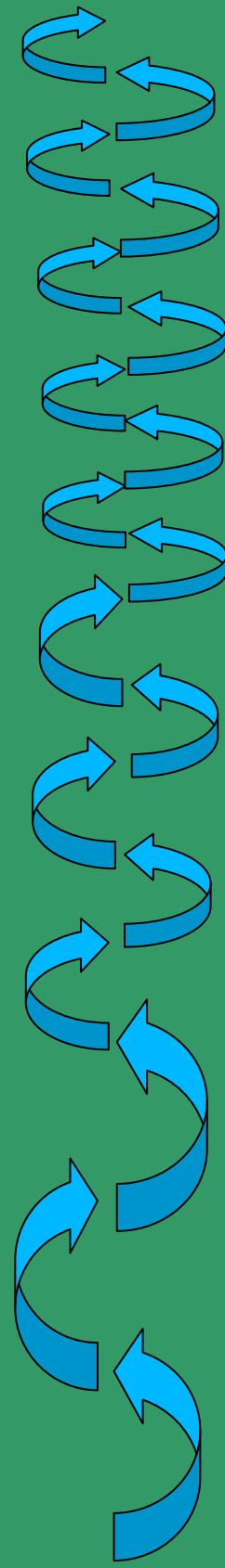


Predators





• Stream efficiency - "spiralizing"



- Hydraulic residence time (velocity)
- Biological residence time
- Biological turnover rate

A photograph of a lush green forest. In the foreground, a large tree trunk with prominent horizontal lenticels and some mossy patches runs diagonally across the frame. A small, shallow stream flows from the background towards the foreground, reflecting the surrounding trees. The water is clear enough to see some aquatic plants at the bottom. The background is filled with more trees and foliage, creating a dense, green canopy.

QUESTIONS?

COMMENTS?

Biological modification of streams



Subsidy-Stress Gradient Odum et al 1979

Usable Input

Enrichment response

Subsidy

Natural

Stress

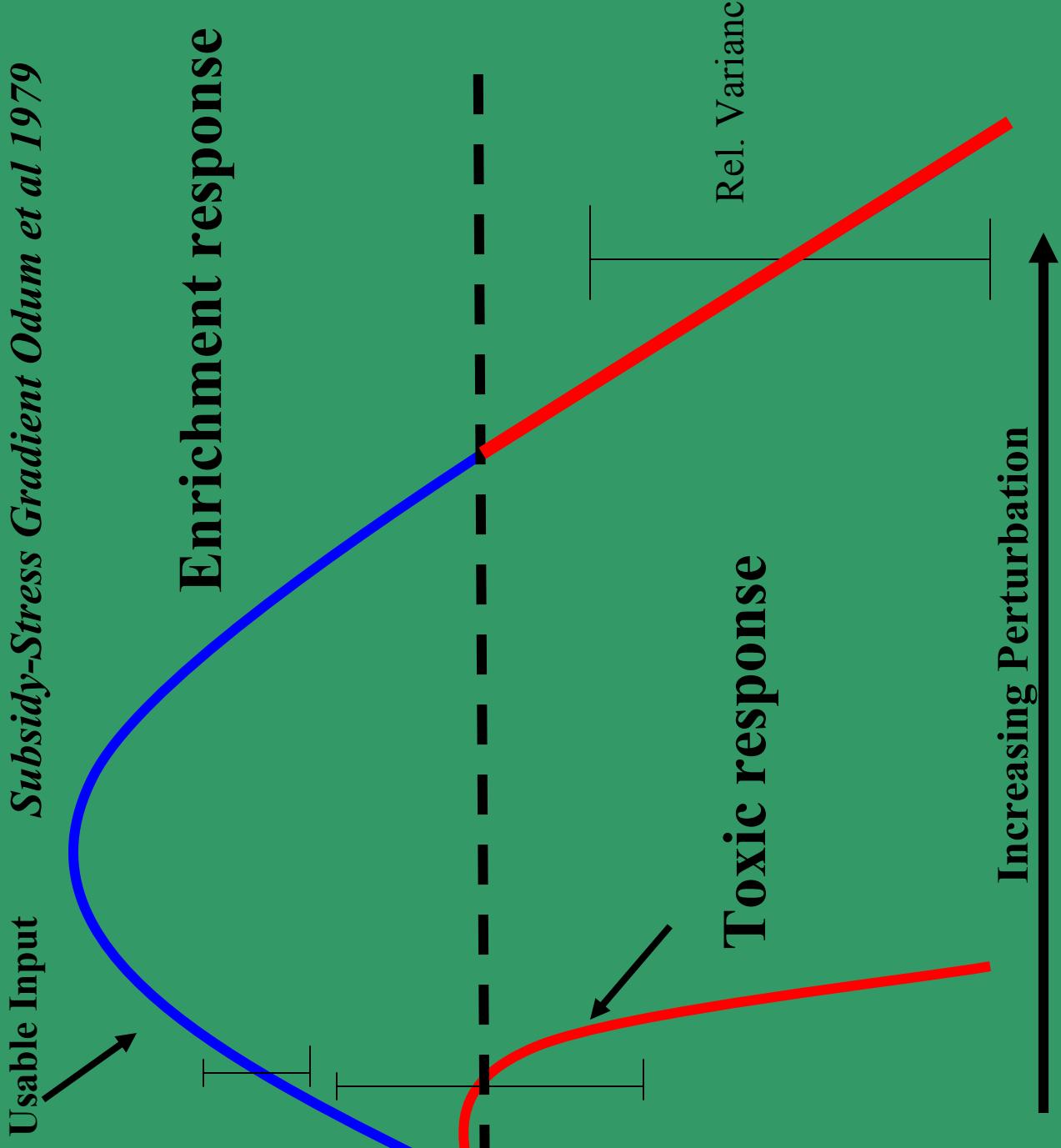
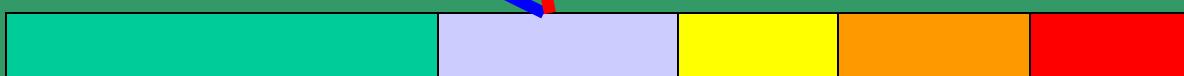
Replacement

Lethal

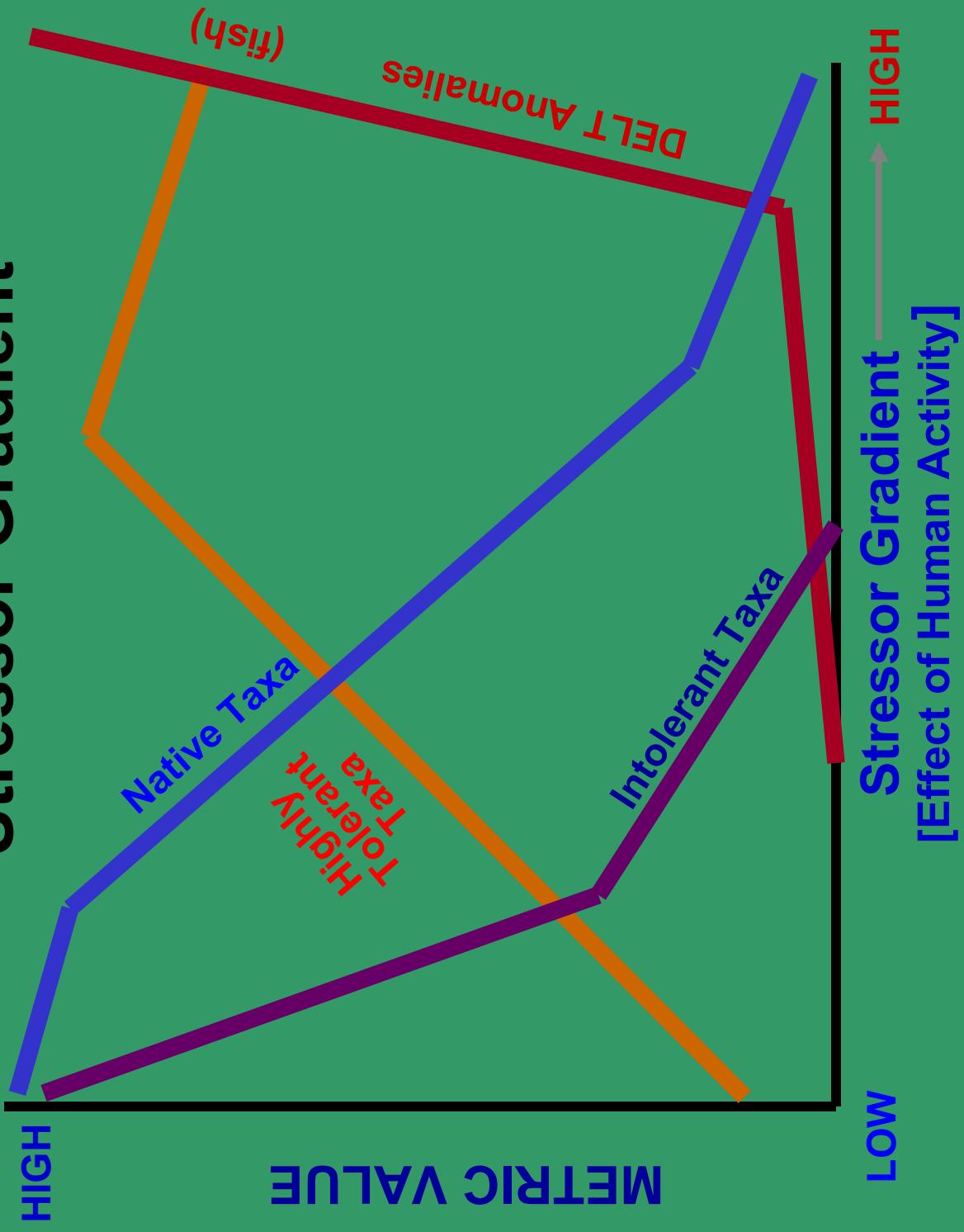
Toxic response

Rel. Variance

Increasing Perturbation



Metric Behavior Along the Stressor Gradient



Courtesy of Chris Yoder, CABB

Mayfly



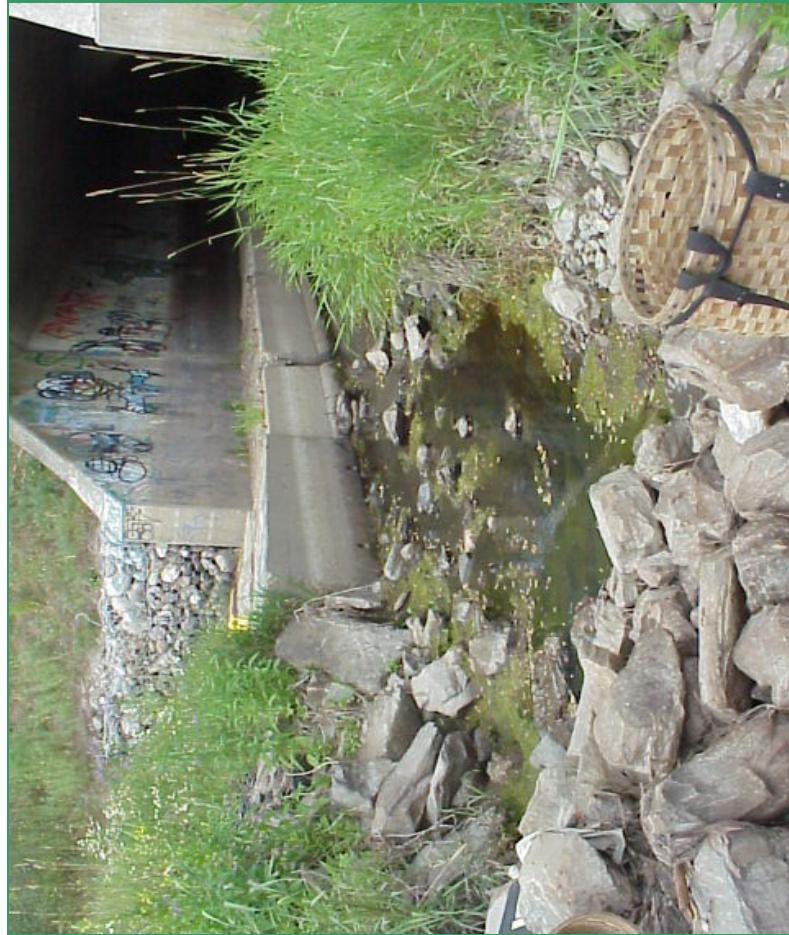
Stonefly

Forested watershed



Slimy Sculpin

Stream draining a shopping mall



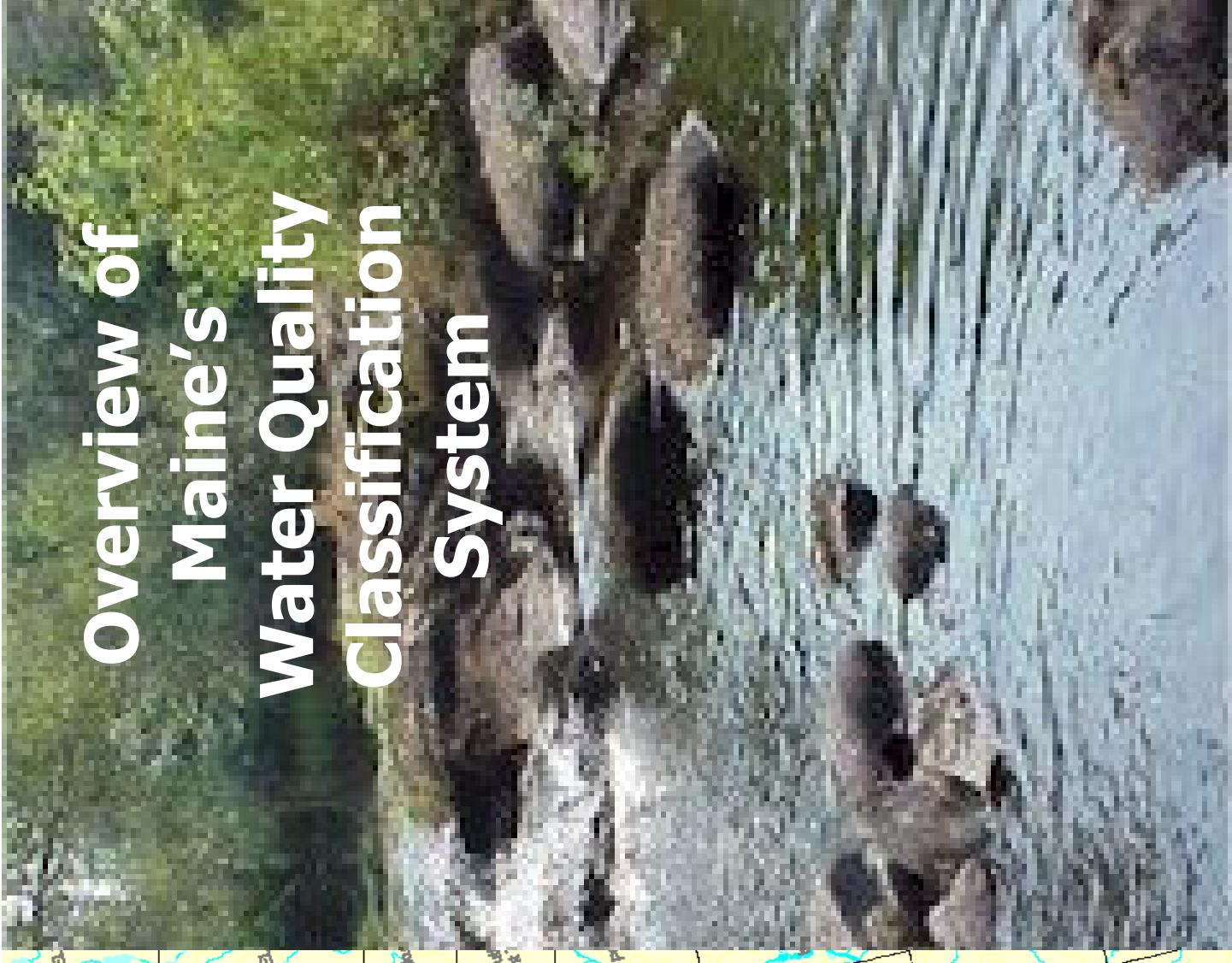
Midges



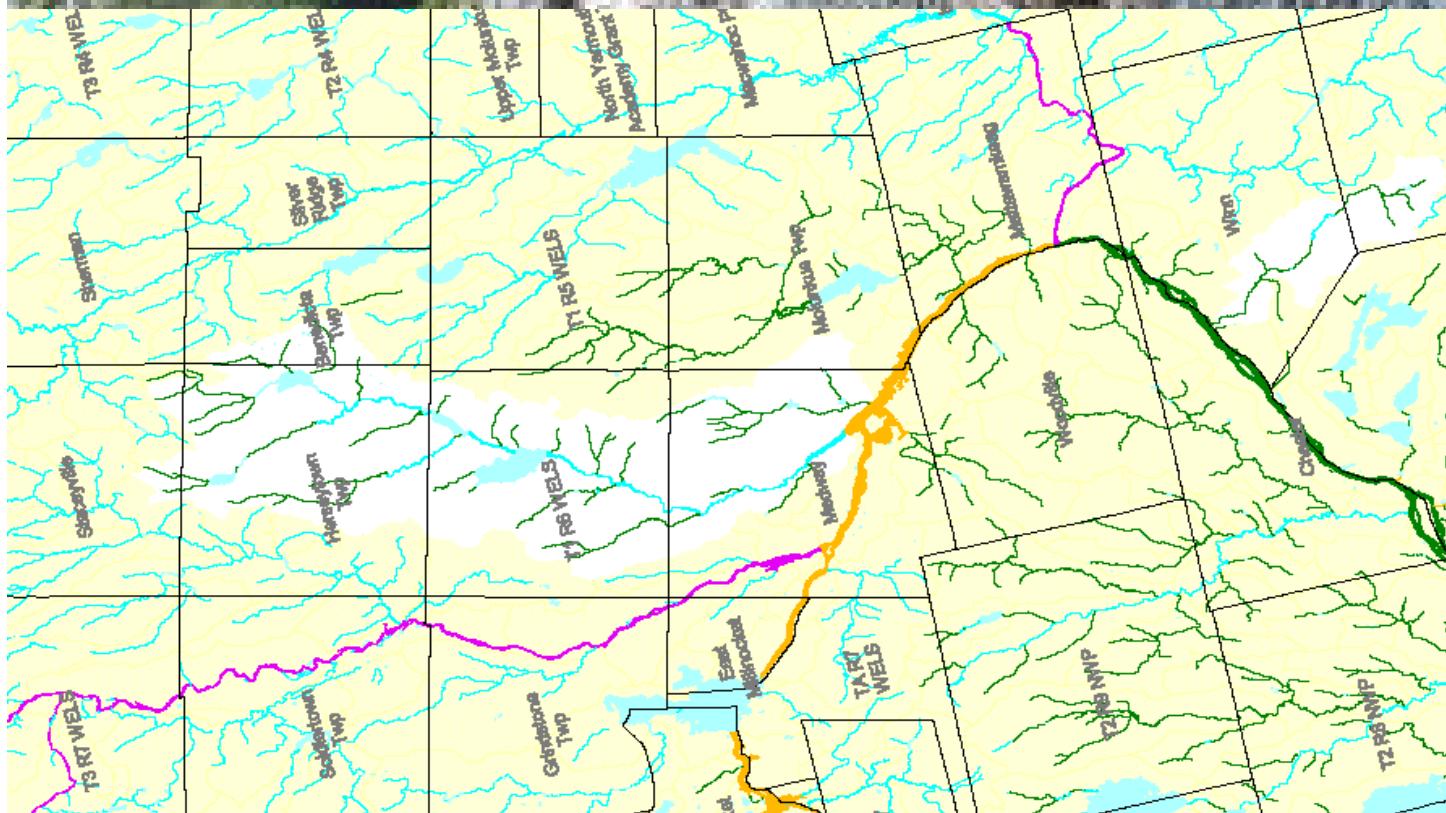
Snails



Leeches



Overview of Maine's Water Quality Classification System



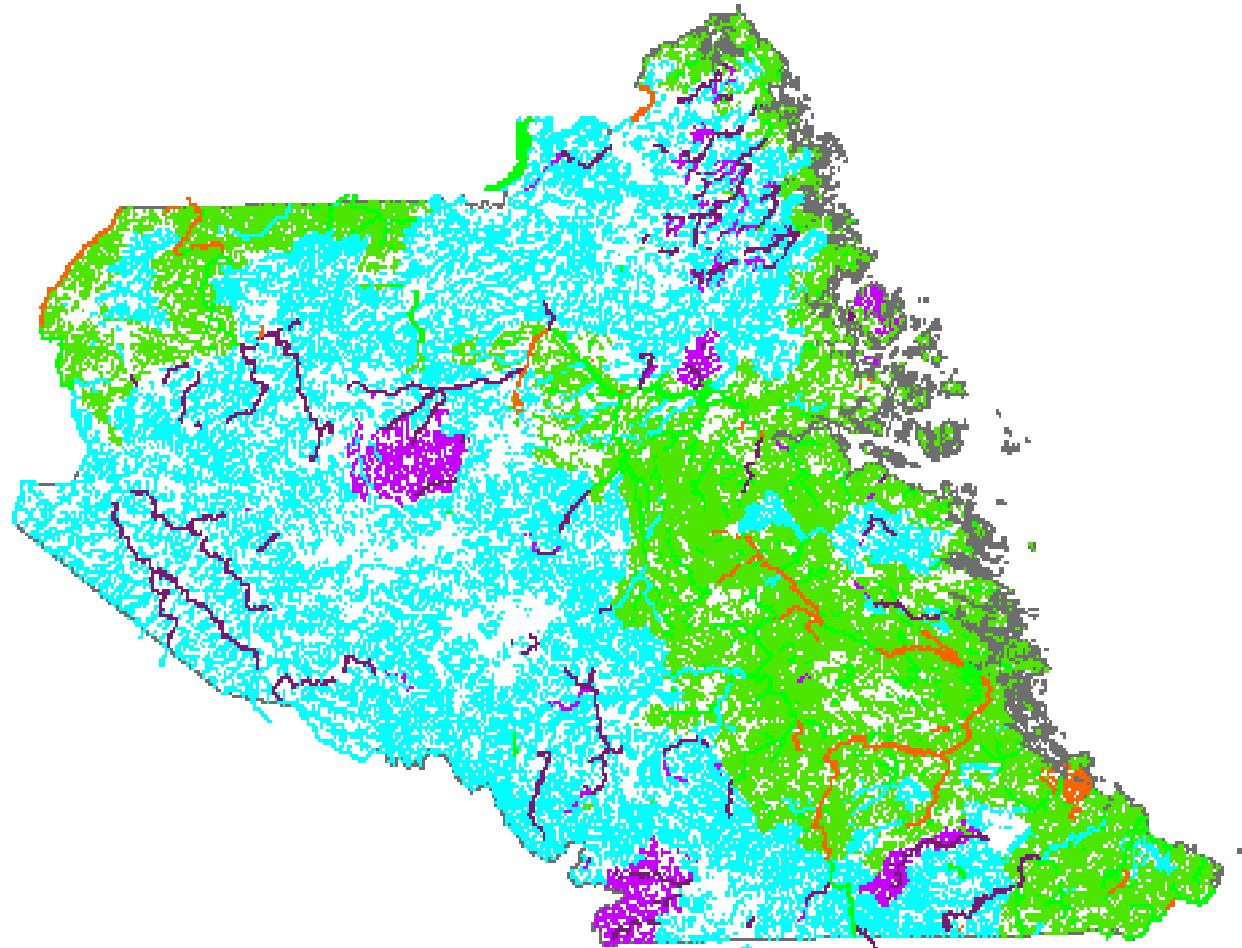
“.....the State’s objective to restore and maintain the chemical, physical and biological integrity of the state’s waters....”

(38 MRSA Section 464(1)

Establish water quality goals for the State

- *Department of Environmental Protection conducts water quality studies*
- *Board of Environmental Protection to hold hearings and propose changes Recommendations to Legislature for final approval*
- *"at least every three years"*



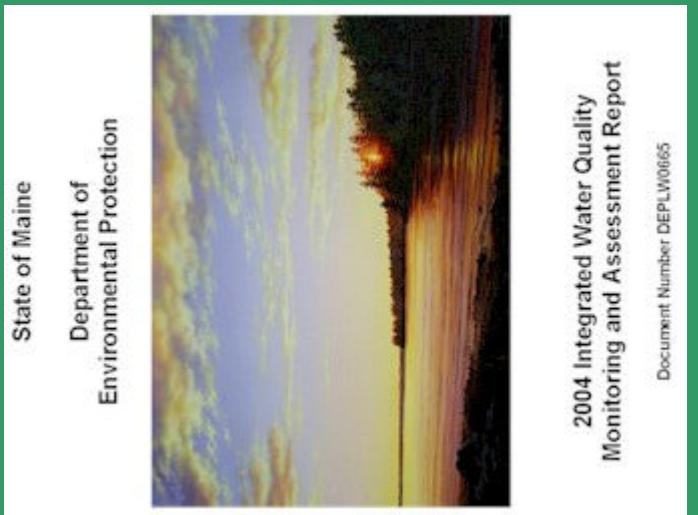


AA = 6% (27%)

A = 44% (22%)

B = 48% (30%)

C = 2% (21%)



Maine River Name	Length (miles)	Fishable ¹ miles	Fishable ¹ Swimmable ² miles	Fishable ¹ Swimmable ² miles	Swimmable miles
Androscoggin ³	124	0	100	0	(0%)
Kennebec ³	145	89	89	89	(61%)
Dead Moose Sandy Sebascoak	22 13 86 50	22 13 86 48	22 13 86 48	22 13 86 48	(100%) (100%) (100%) (96%)
Penobscot ³	80	24	71	24	(29%)
East Branch Mattawamkeag Piscataquis West Branch	46 48 47 36	46 48 47 31	46 48 47 33	46 48 47 28	(100%) (100%) (100%) (78%)
Presumpscot	23	16	16	16	(70%)
Saco	81	80.5	80.5	80.5	(99%)
Saint Croix	30	27	30	27	(90%)
Saint John ⁴ Allegash	161 64	161 64	159 64	159 64	(99%) (100%)
Aroostook Fish	69 13	69 13	69 13	69 13	(100%) (100%)
Union	3	3	3	3	(100%)
TOTAL MILES	1141	887.5	1037.5	882.5	

2004 Integrated Water Quality Monitoring and Assessment Report

Document Number DEPLW0865

• Determining Attainment Status

• Public & Legislative Education

• "Stream Team" Program Goals

• Town & Regional Planning Efforts

• Reports & Federal Documents

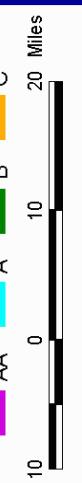
Water Classifications

Kennebec River Areas

Estuarine & Marine Waters
SA SB SC

Stream & River Classifications

AA A B C



Maine Waters
Major River Divides
Political Boundaries



A photograph of a lush green forest. In the foreground, a large tree trunk with prominent horizontal lenticels and some mossy patches runs diagonally from the bottom left towards the center. A small, shallow stream flows from right to left through the middle of the scene, reflecting the surrounding dense foliage and the sky above. The background is filled with tall, thin trees and various shades of green leaves.

QUESTIONS?

COMMENTS?